



Underground Workings Detection at the Fimiston Open Pit KCGM

By

JinJun Jiang

Senior Geotechnical Engineer

Kapila Karunaratna

Technical Service Superintendent

Trevor Jones

Senior Mining Engineer - void control





Underground Workings Detection at the Fimiston Open Pit KCGM

- ❖ A Joint Venture between Newmont Australia and Barrick Gold of Australia
- ❖ Produces 800,000 gold ounces annually.
- ❖ The total movement is about 84 Mt per annum
- ❖ The current pit is about 2.5 km long, 1.2 Km wide and 300 metres deep.
- ❖ The ultimate pit will be about 3.6 km long, 1.5 km wide and 600 m deep.





Underground Workings Detection at the Fimiston Open Pit KCGM

- ❖ Open pit is mining in the area called Golden Mile with over 100 year mining history
- ❖ > 3000 km old mine headings and over 700 stopes under the open pit area
- ❖ The stopes extend to over 1000 m below surface level

Kalqurli Shaft 10th Kalqurli

Lake View 6th Star Shaft LV6S

Main Shaft B Perseverance

Jimiston Post Office

Oroaya Shaft & Treatment Plant G.M.K.

Treatment Plant K.O.T.

5th Kalqurli Shaft 5th Kalqurli

Svanhoe Shaft LV6S

Pemeroy Shaft O.N.B.

Associated Shaft G.M.K.

Treatment Plant LV6S

Chaffers Shaft LV6S

Edwards Shaft LV6S

Monty's Shaft

Hainault

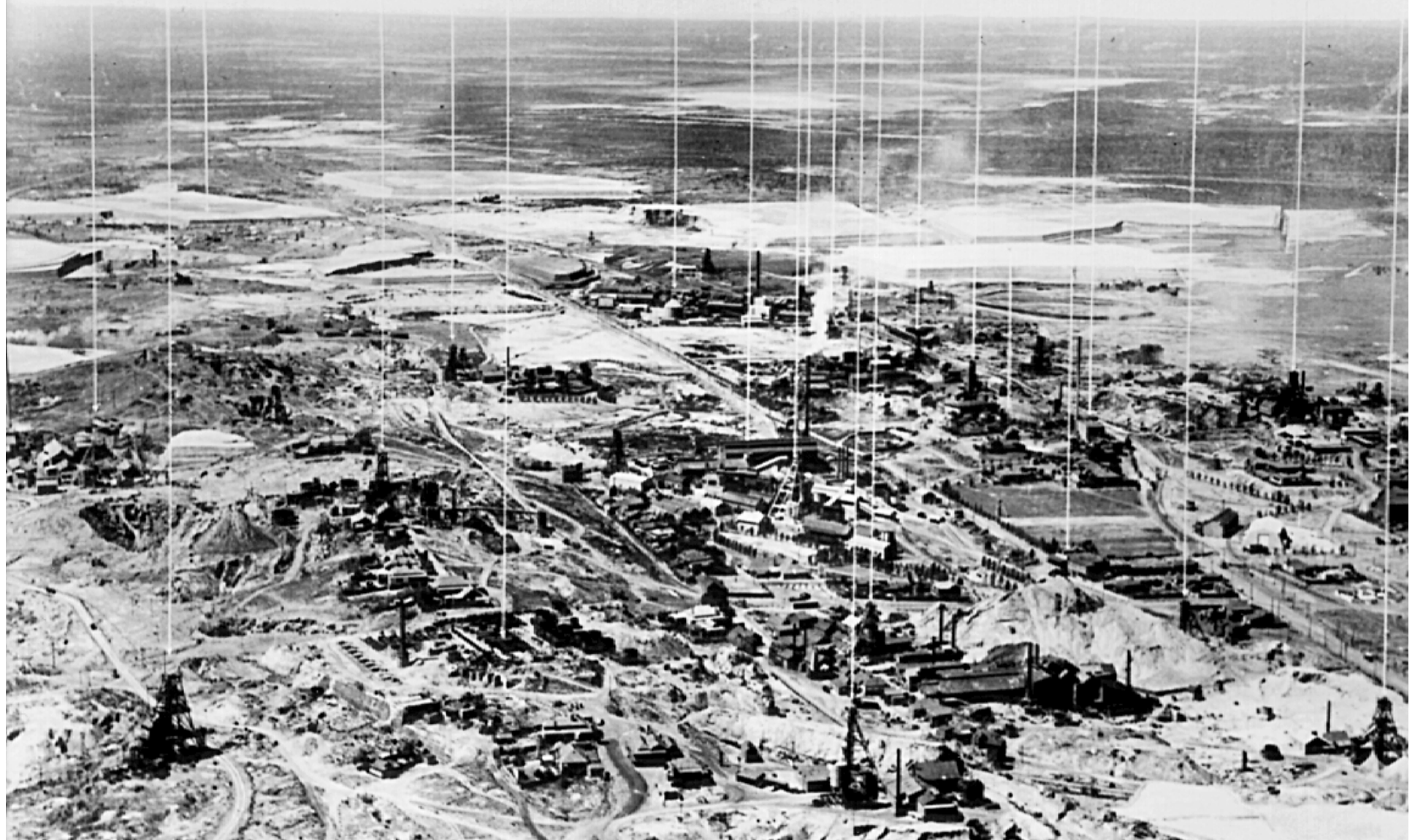
Tailing Dump G.B.P.

Treatment Plant (defunct) Kalqurli G.M.

Lone Shaft G.B.P.

Main Shaft G.B.P.

Treatment Plant G.B.P.







Planned subsidence by blasting

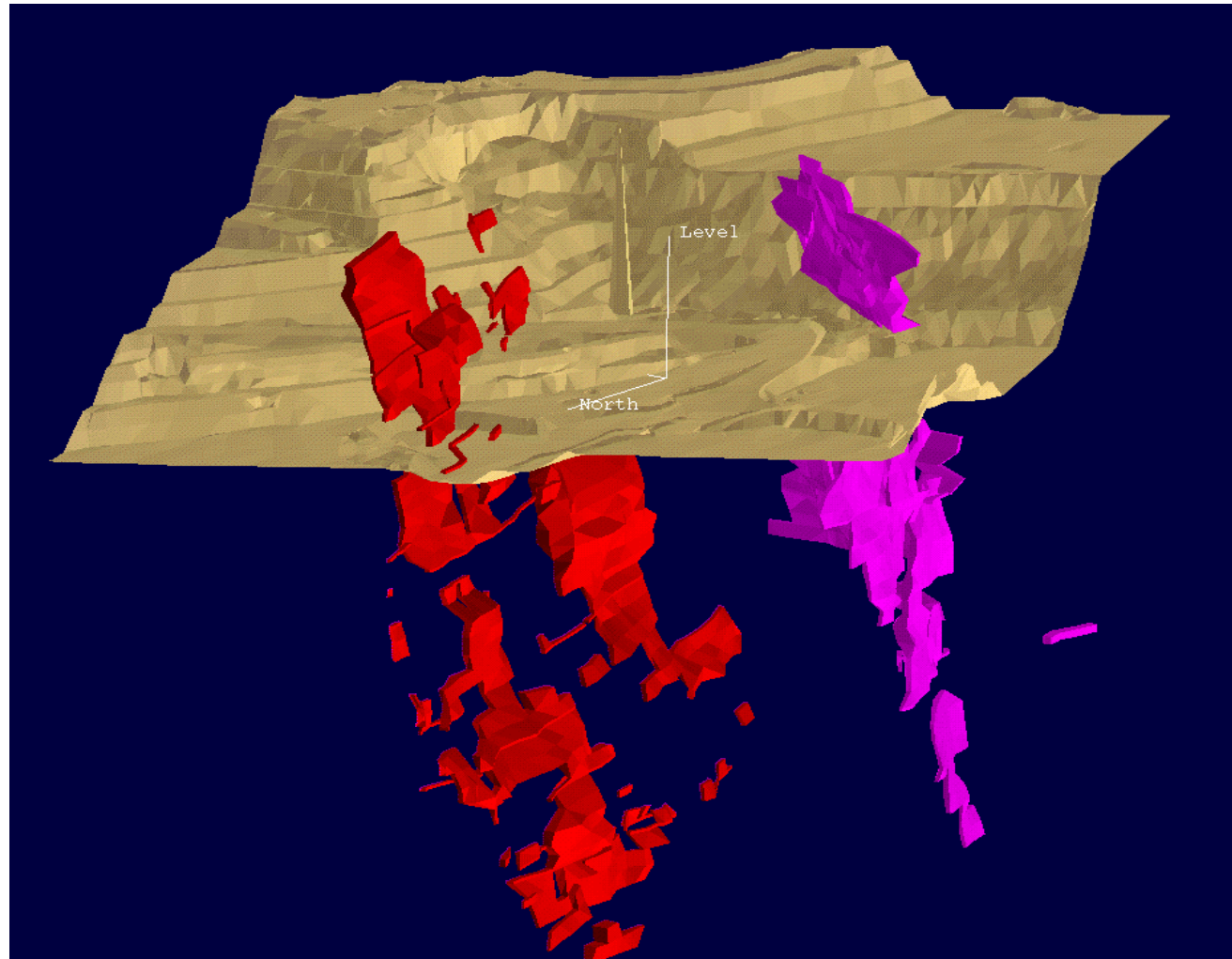




VOIDS MANAGEMENT

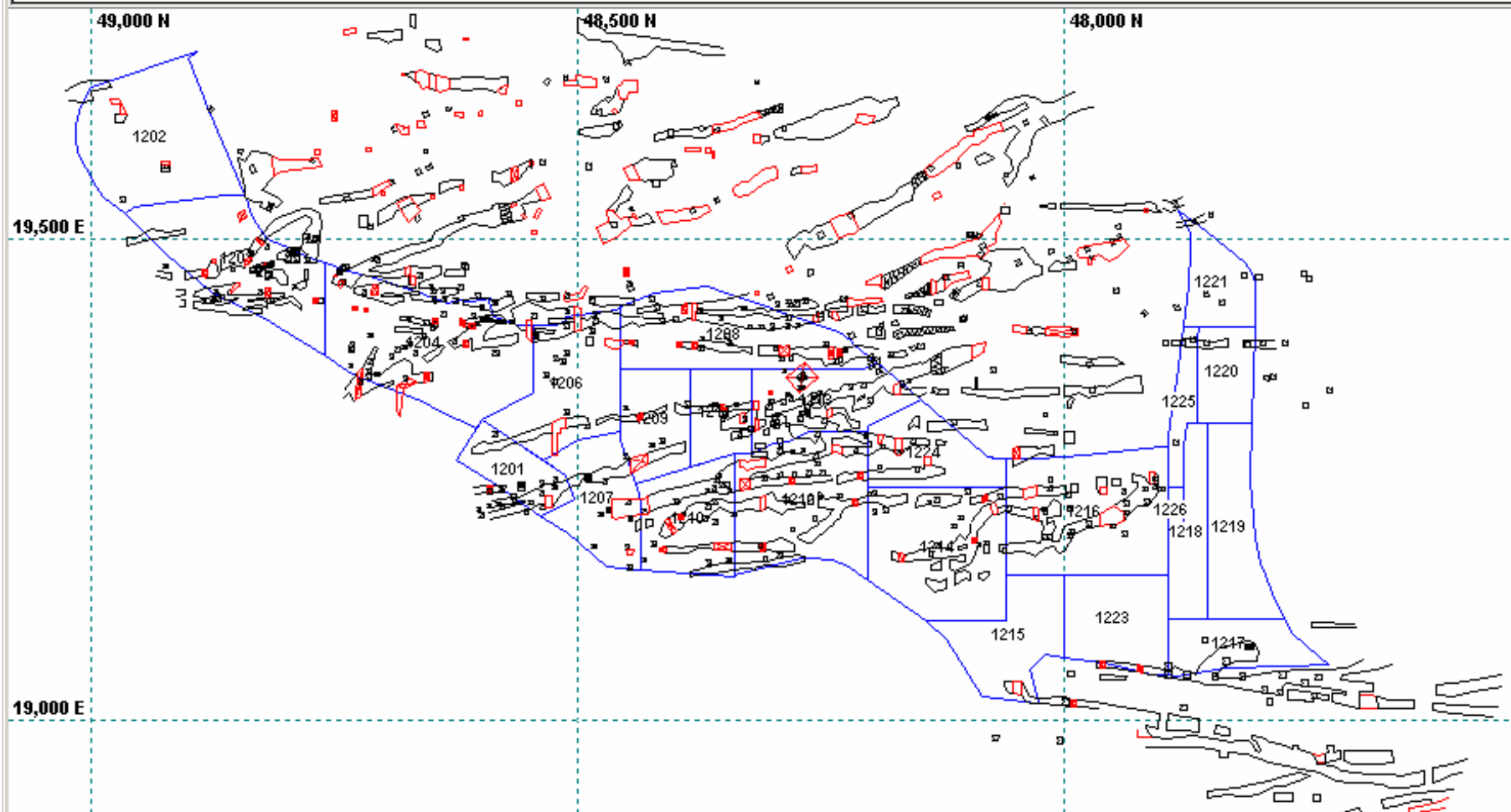
- ❖ All the old plans and sections have been digitised and can be displayed in 2D and 3D
 - ◆ Challenge - the difference between old records and real situation!
 - ◆ Major problem was the lack of agreement on where North was!!!
- ❖ Procedures developed for mining through old workings
- ❖ Aiming for 'no surprise'

3D Model



Pits III - UserLevel 9

File Display Query Options Probes Geology Help



<p>▲ 280 Main Display</p> <p>▼ 50.10</p> <p>Step Up Step Down</p> <p><input type="checkbox"/> Activate Secondary Display</p> <p>▲ 320 Secondary Display</p> <p>▼ Show</p>	<p><input type="radio"/> Top 280</p> <p><input checked="" type="radio"/> Bottom 295</p>	<p>View Options</p> <p>Flash</p> <p>Probe Results</p> <p>RC Holes</p> <p>Hole Traces</p> <p>Levels</p>	<p>Label Options</p> <p>Probes</p> <p>RC Holes</p> <p>Res Def Holes</p> <p>Hole Traces</p>	<p>Output</p> <p>Legend</p> <p>Red / White Tapes</p> <p>Exclusion Zones</p> <p>Levels</p> <p>Stopes</p> <p>Deep Hole Zones</p>	<p>Blast Stats</p> <p>Pit Shell</p> <p>Current Face</p> <p>Map Sheets</p> <p>Ore Blocks</p>	<p>Interp Stopes</p> <p>Probe Results</p> <p>Shadow Above</p> <p>Shadow Below</p>
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Zoom Count = 2 47,661.14 N 19,734.67 E



UNDERGROUND WORKINGS FLAGGING

❖ Black/white tape

- ◆ Indicates a known area of underground workings that has low probability of developing a void to surface and is deemed safe for heavy vehicle access if equipped with a roll-over-protection system.

❖ Red/white tape

- ◆ Indicates a known or suspected void area with insufficient cover. In other words, the area has a high probability of developing a void to surface.



UNDERGROUND WORKINGS DELINEATION and DETECTION

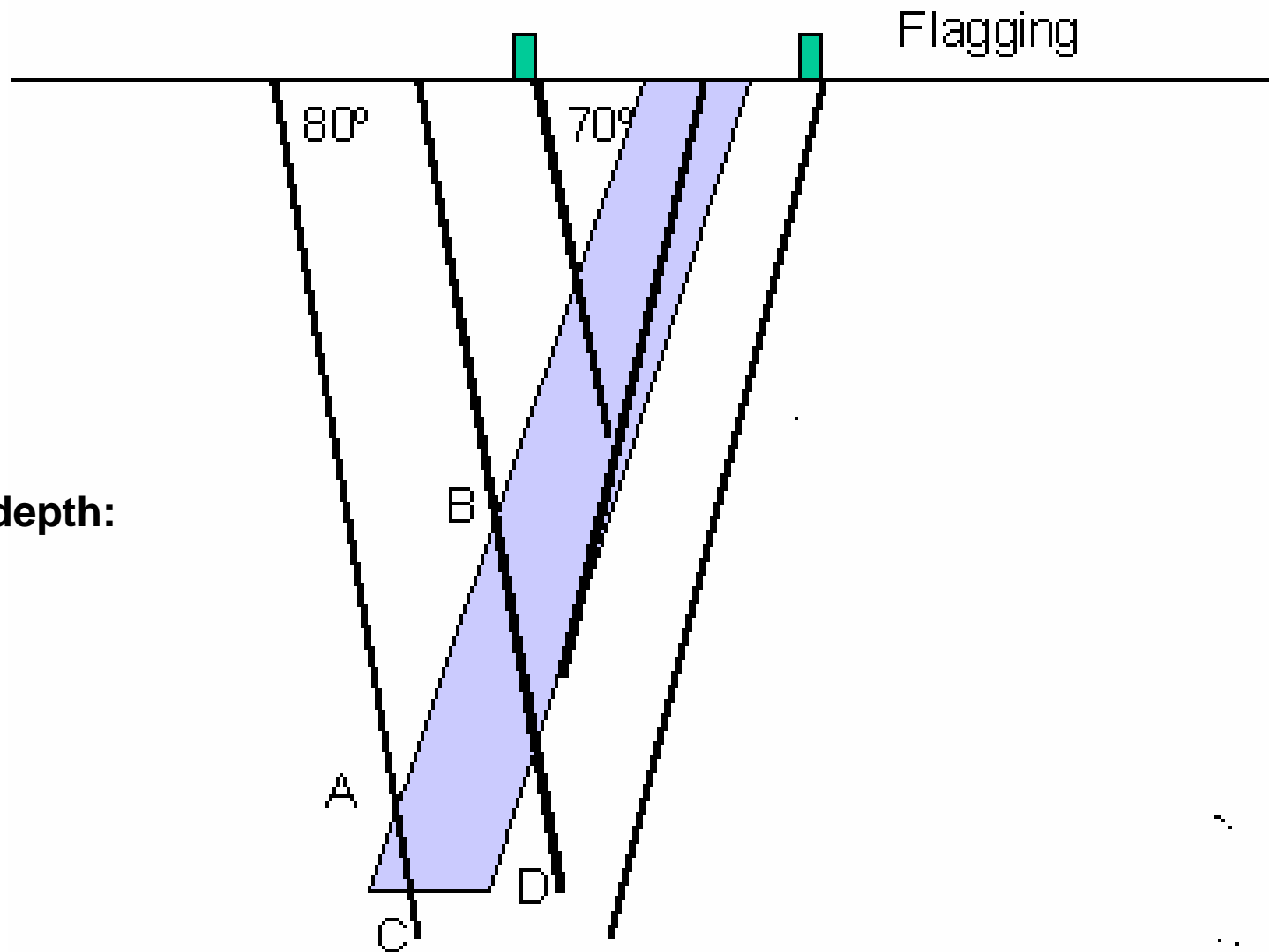
- ❖ **Probe drilling**
- ❖ **RC (reverse circulation) drilling**
- ❖ **Cavity Auto Laser Scanner (C-ALS)**
- ❖ **Geophysical methods**

Probe Drilling



Probing

Probe depth:
16 m

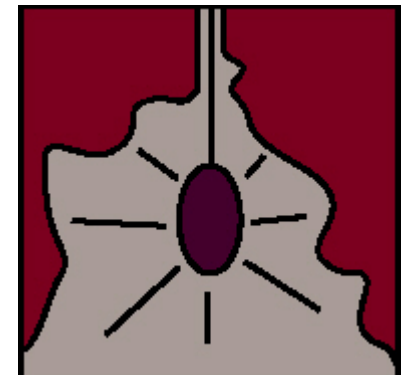


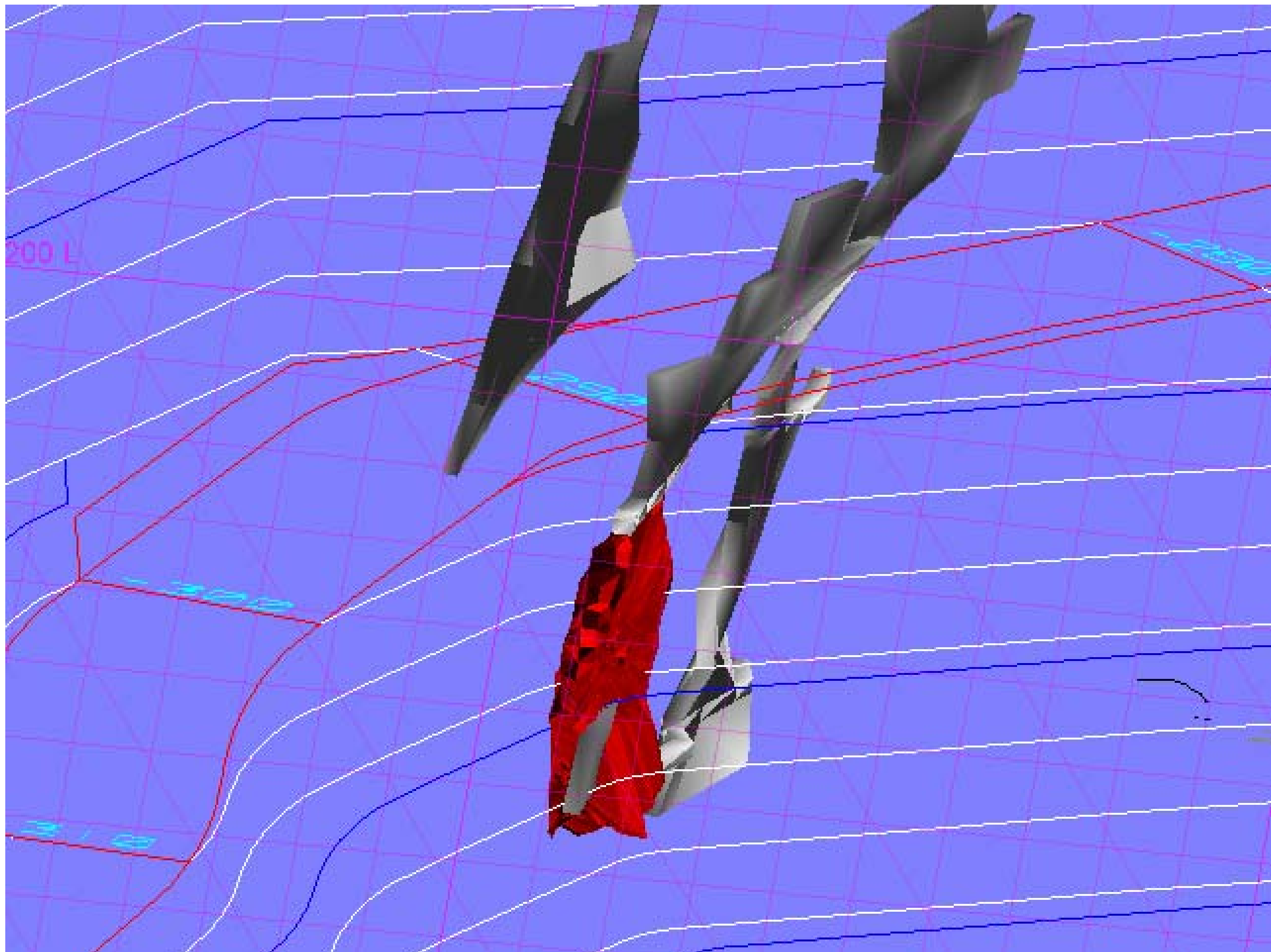
RC DRILLING

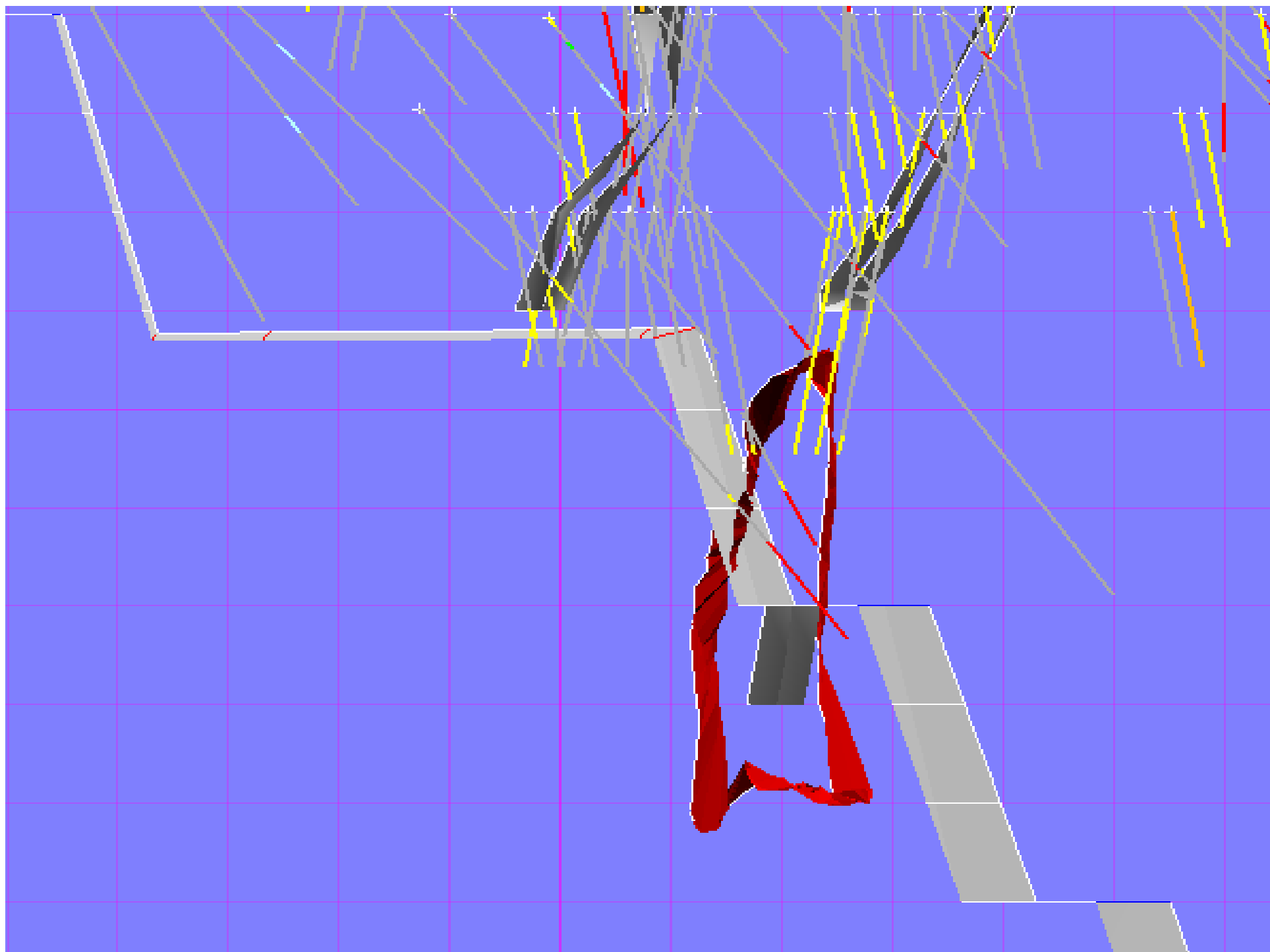
- ❖ **RC holes are drilled for grade control at 8m x 10m pattern with 38 to 50 m depth in ore zones (stope areas) for grade control purpose.**
- ❖ **RC holes provide good information for void detection and delineation a few benches ahead.**



Cavity Auto Laser Scanner - provide 3D imagine









GEOPHYSICAL METHODS

Major methods trialed at KCGM

- ❖ Ground Probing Radar (GPR)
- ❖ Micro-gravity
- ❖ Resistivity imaging method
- ❖ Seismic tomography (surface)
- ❖ Transient Electric Magnetic (TEM)
- ❖ Cross-hole radio wave tomography

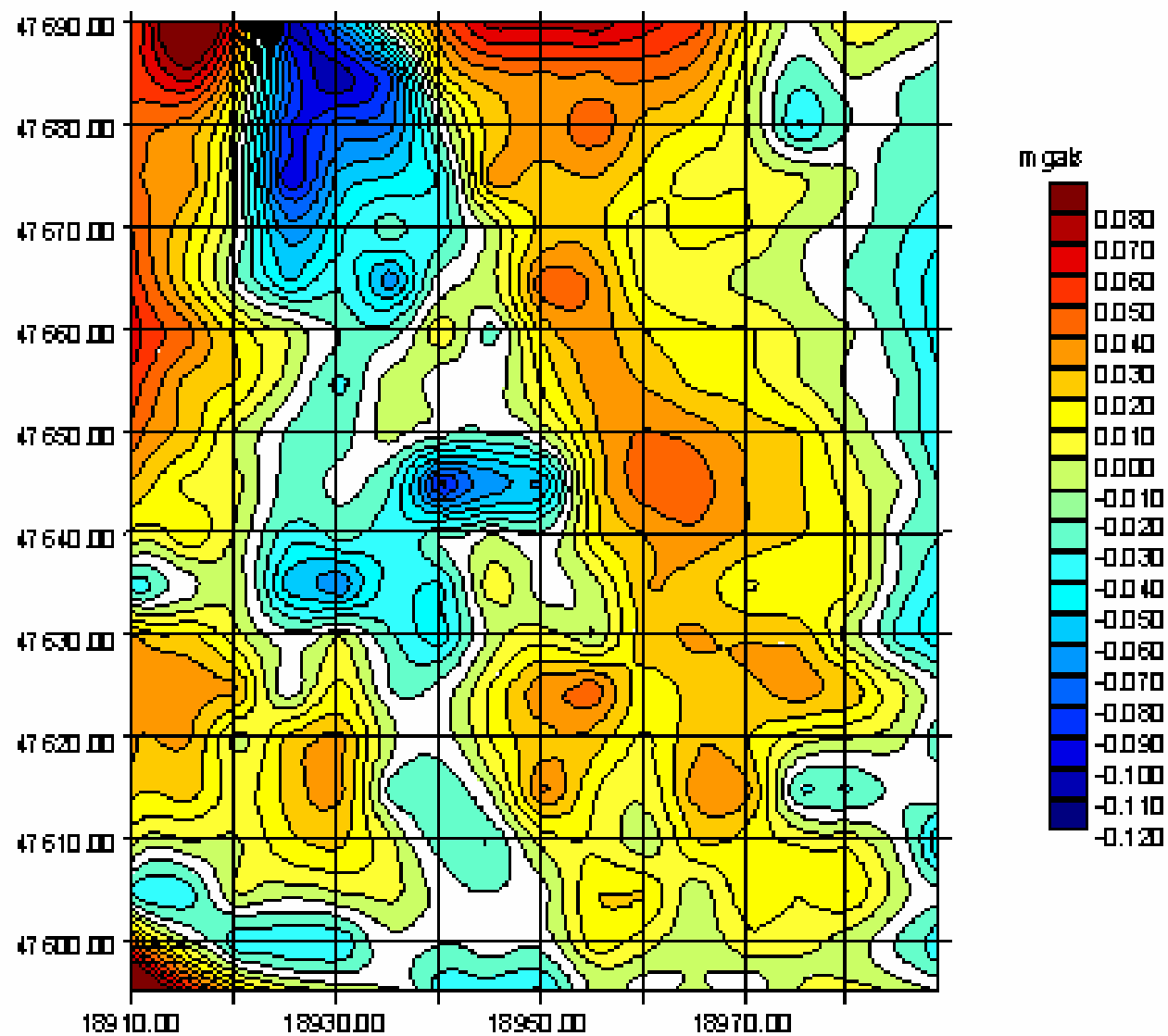
GPR

- ❖ **Penetrating depth < 15m**
- ❖ **Success rate 30 -70%**
- ❖ **30% false anomalies**
- ❖ **Major difficulties:**
 - ◆ Broken layer from subdrill (1-2 metres)
 - ◆ Saline water sprayed on ground for dust suppression
 - ◆ Complex ground condition, structures
 - ◆ Others unknowns
- ❖ **Conclusion: easy to operate but not reliable**

Micro-gravity

- ❖ Micro-gravity measures gravity at each monitoring station.
- ❖ Low gravity indicates mass loss -> void
- ❖ Pattern used 5m x 5m

Micro-gravity



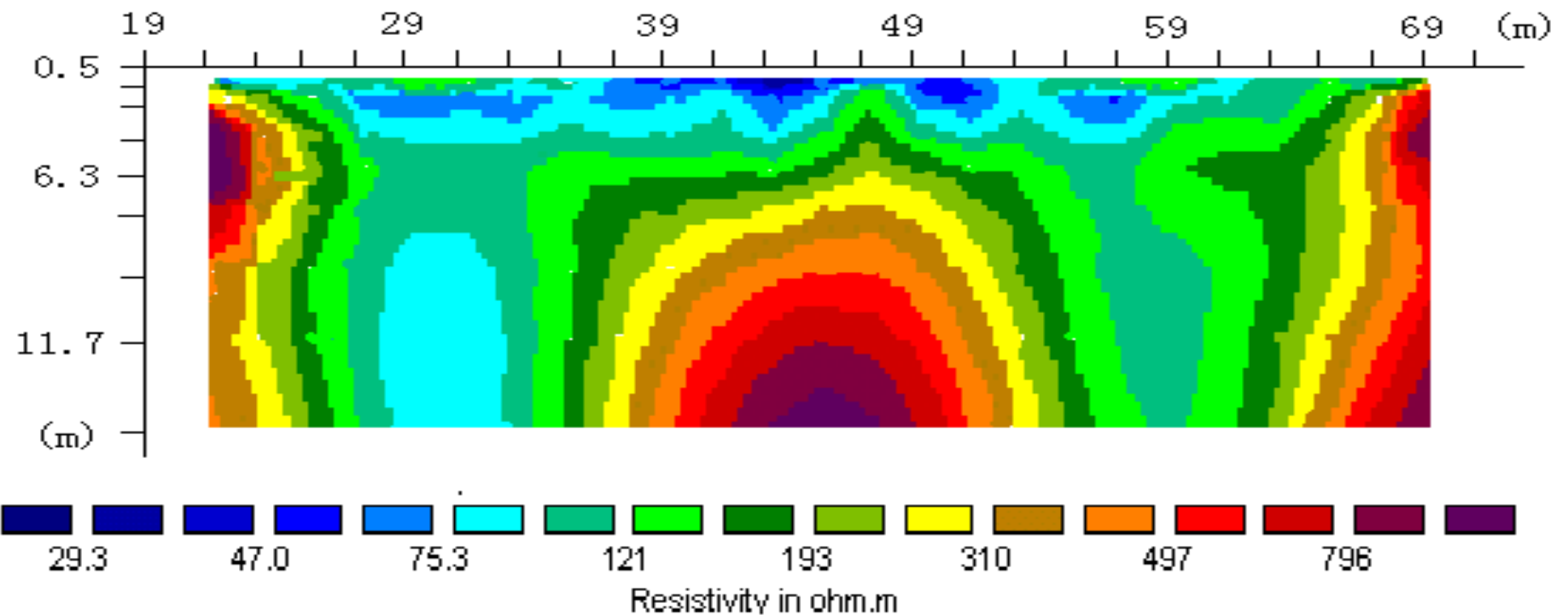
Micro-gravity

❖ Difficulties with Micro-gravity

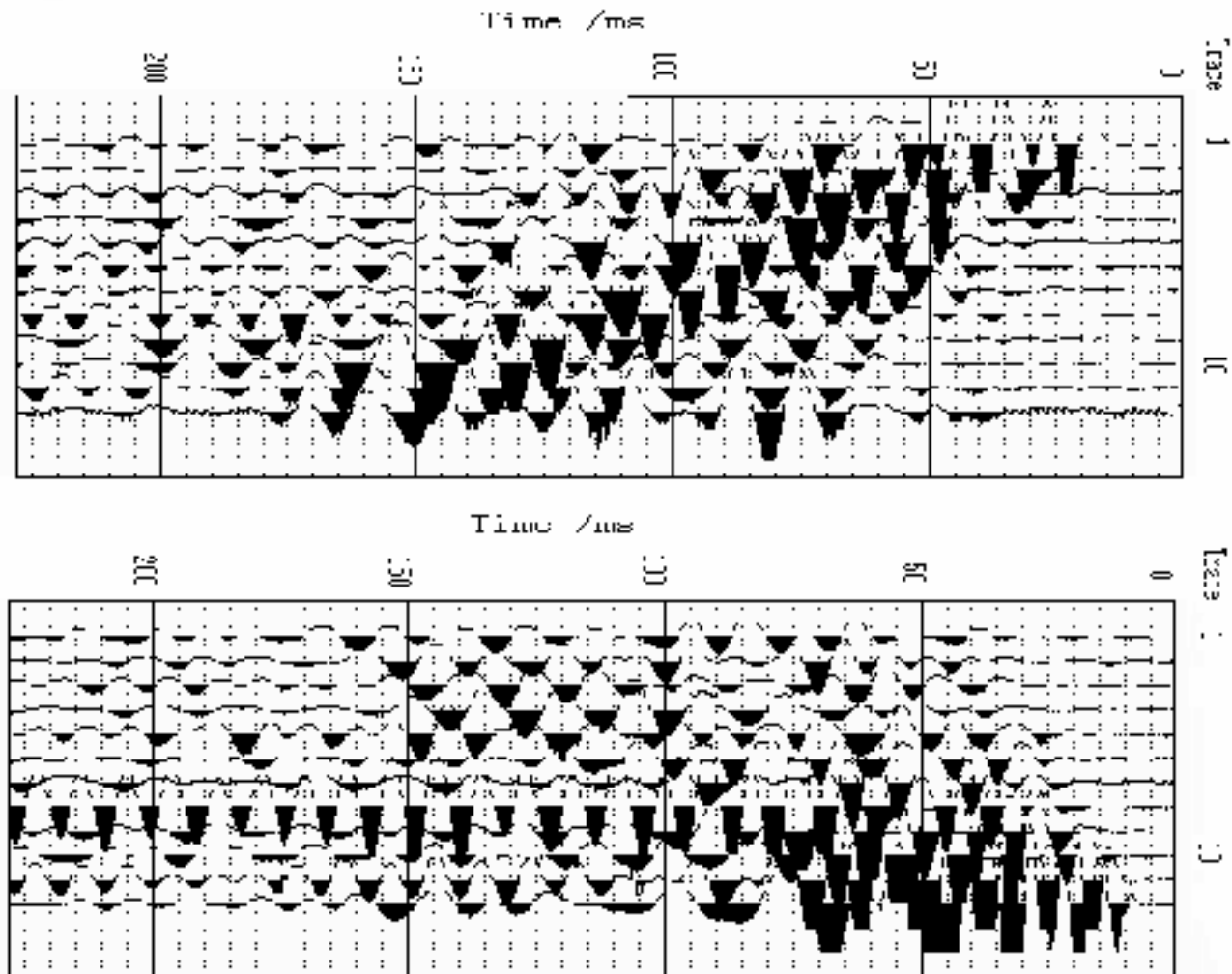
- ♦ Slow data acquisition: 10 stations per hour**
- ♦ Uncertain with the size, depth, width and dip direction**
- ♦ Slow data processing (Terrain correction)**

❖ Suitable for void detection but not for delineation

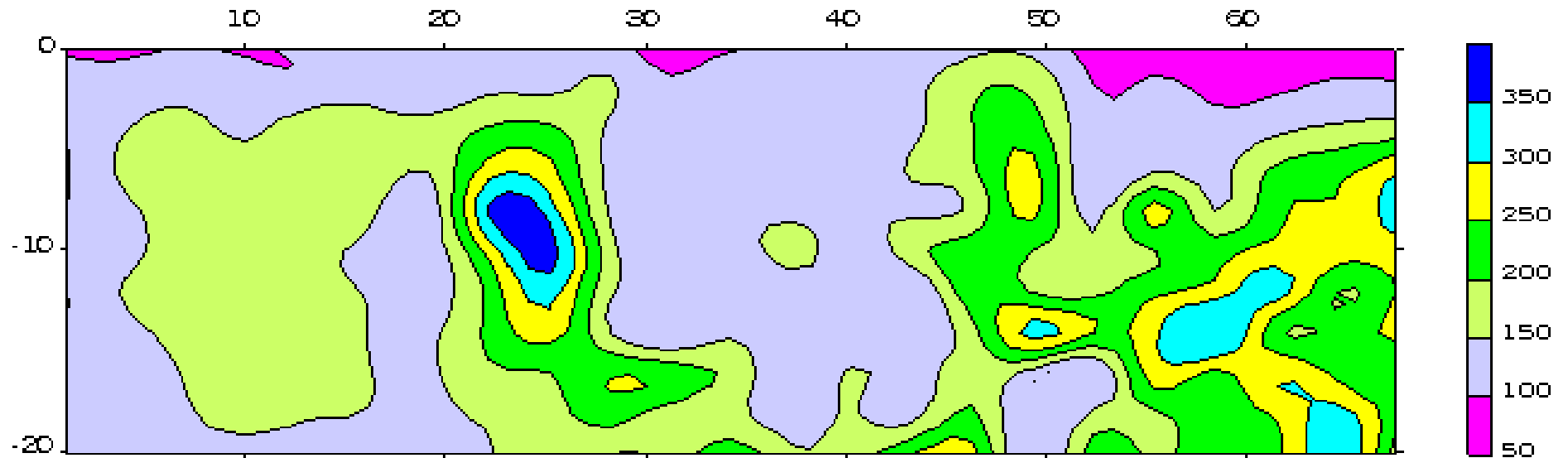
The Multi-Electrode Resistivity Method



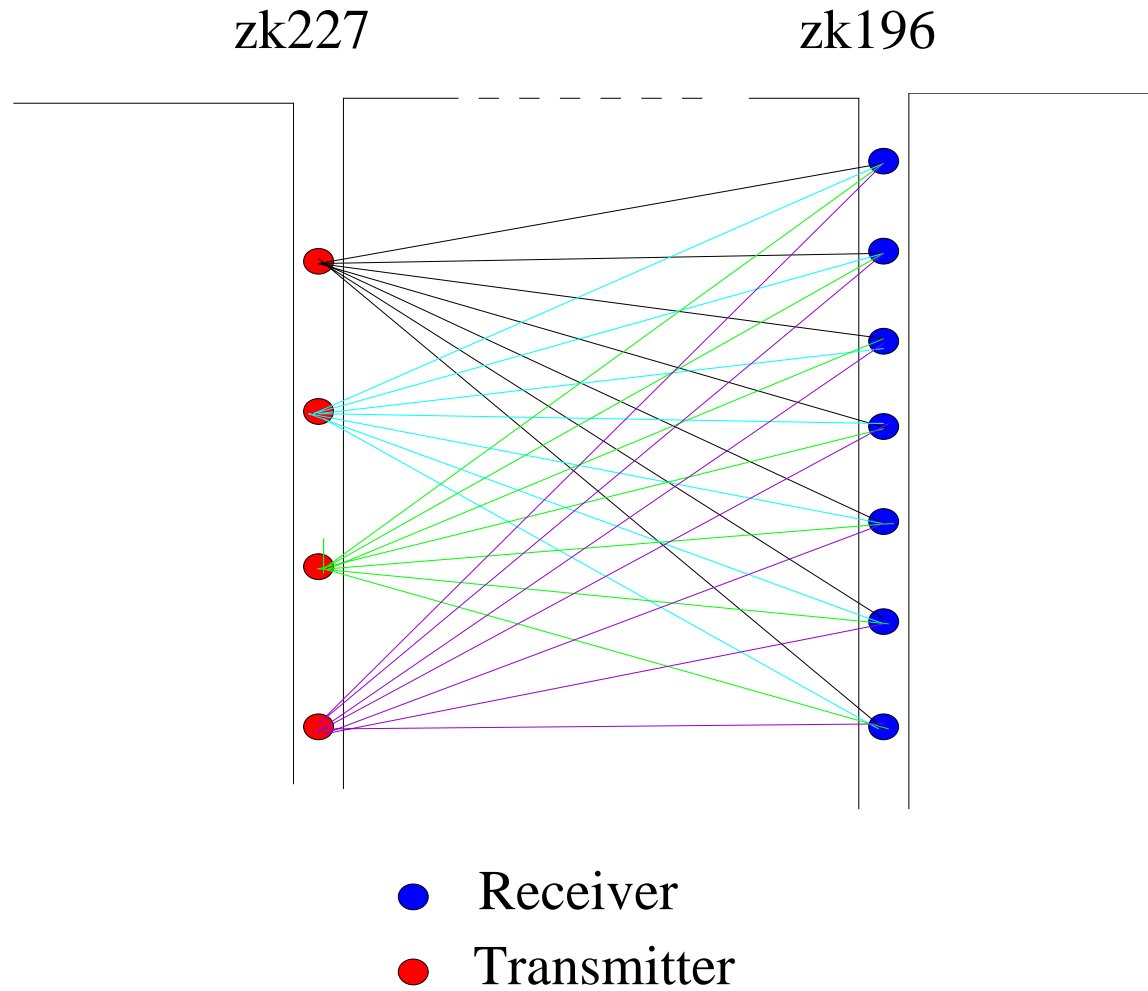
Seismic Tomography



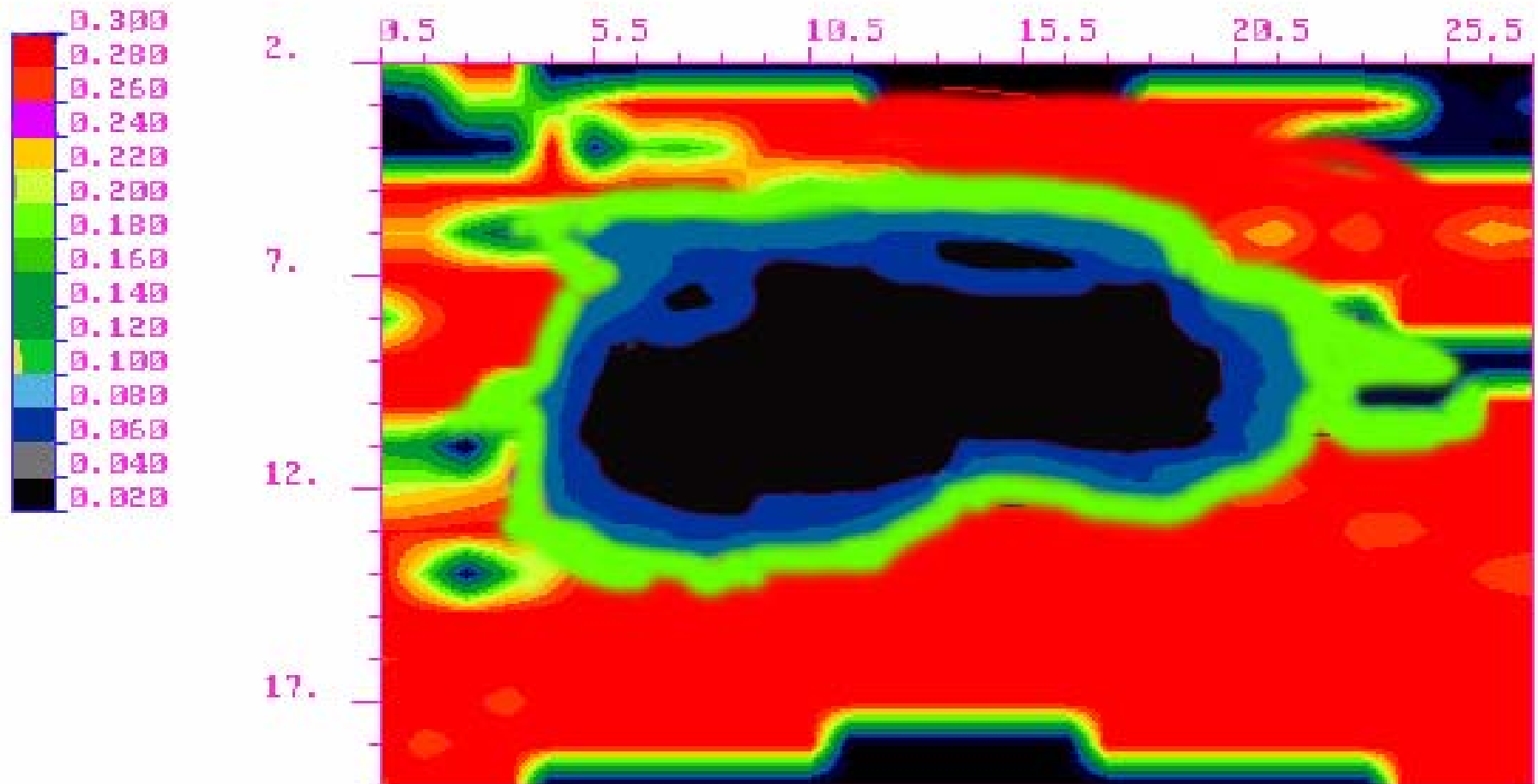
The Transient Electromagnetic Method (TEM)



Cross-hole Radio Wave



Cross-hole Radio Wave



Conclusions (at KCGM)

- ❖ Geophysical tools work well for ideal situation such as uniform material but not effective for mines with complex rock conditions
- ❖ Geophysical tools may be used for void detection (looking for surprise) but not for delineation
- ❖ Cavity Auto Laser Scanners are very useful for void mapping
- ❖ Probe drilling is the most reliable method for void delineation



End of presentation

❖ Questions ?